

Application
for
United States Letters Patent

To all whom it may concern:

Be it known that

I, Taka-Aki Sato
have invented certain new and useful improvements in

Gene Encoding NADE, p75^{NTR}-Associated Cell Death
Executor and Uses Thereof

of which the following is a full, clear and exact description.

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5 This invention described herein was supported by
National Institutes of Health grant R01-GM55147.
Accordingly, the United States Government has certain
rights in this invention.

Background of the Invention

Expression of NADE mRNA was found highest in brain, heart, and lung. NADE specifically binds to p75^{NTR}ICD both *in vitro* and *in vivo*. Co-expression of NADE together with p75^{NTR} dramatically induced Caspase-2 and Caspase-3 activities to cleave PARP (poly (ADP-ribose) polymerase) and fragmentation of nuclear DNA in 293T cells, but NADE without p75^{NTR} did not show apoptosis, suggesting that NADE expression is necessary for p75^{NTR}-

mediated apoptosis but is not sufficient to trigger apoptosis. Moreover, NGF dependent recruitment of NADE to p75^{NTR}ICD was observed in a dose dependent manner and NADE significantly inhibits NF-kB activation.

5 Interestingly, NADE protein is found to be ubiquitinated as a substrate for protein degradation pathway. Taken together, NADE is the first signal adaptor molecule identified in involvement of p75^{NTR}-
10 in the pathogenesis of neurogenetic diseases.

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This invention provides an isolated nucleic molecule encoding a polypeptide capable of binding a p75^{NTR} receptor.

This invention provides a method of producing a polypeptide capable of binding a p75^{NTR} receptor which comprises growing host cells selected from a group consisting of bacterial, plant, insect or mammalian cell, under suitable conditions permitting production of the polypeptide.

This invention provides an antisense oligonucleotide having a nucleic acid sequence capable of specifically hybridizing to an mRNA molecule encoding a polypeptide capable of binding a p75^{NTR} receptor.

This invention provides a purified polypeptide capable of binding a p75^{NTR} receptor.

This invention provides a method of producing a polypeptide capable of binding a p75^{NTR} receptor into a suitable vector which comprises: (a) inserting a nucleic acid molecule encoding the polypeptide capable of binding a p75^{NTR} receptor into a suitable vector; (b) introducing the resulting vector into a suitable host cell; (c) selecting the introduced host cell for the expression of the polypeptide capable of binding a p75^{NTR} receptor; (d) culturing the selected cell to produce the polypeptide capable of binding a p75^{NTR} receptor; and (e) recovering the polypeptide capable of binding a p75^{NTR} receptor produced.

This invention provides a method of identifying a compound capable of inhibiting binding between p75^{NTR}

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This invention provides a method of determining physiological effects of expressing varying levels of a polypeptide capable of binding a p75^{NTR} receptor in

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5 This invention provides a method to detect a neurodegenerative disease in a subject by detecting expression levels of a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR}.

10 This invention provides a method of identifying a compound, which is an apoptosis inhibitor, said compound is capable of inhibiting specific binding between a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR} receptor, so as to prevent

15 apoptosis which comprises: (a) contacting the polypeptide capable of binding a p75^{NTR} receptor with a plurality of compounds under conditions permitting binding between a known compound previously shown to be able to displace the polypeptide capable of binding

20 a p75^{NTR} receptor and the p75^{NTR} receptor and the bound p75^{NTR} receptor to form a complex; and (b) detecting the displaced polypeptide capable of binding a p75^{NTR} receptor or the complex formed in step (a), wherein the displacement indicates that the compound is

25 capable of inhibiting specific binding between the polypeptide capable of binding a p75^{NTR} receptor and the p75^{NTR} receptor.

30 This invention provides a method of identifying a compound, which is an apoptosis inhibitor, said compound is capable of inhibiting specific binding between human HGR74 protein and p75^{NTR} receptor, so as to prevent apoptosis which comprises: (a) contacting the human HGR74 protein with a plurality of compounds

35 under conditions permitting binding between a known compound previously shown to be able to displace the human HGR74 protein and the p75^{NTR} receptor and the

bound p75^{NTR} receptor to form a complex; and (b)
detecting the displaced human HGR74 protein or the
complex formed in step (a), wherein the displacement
indicates that the compound is capable of inhibiting
5 specific binding between the human HGR74 protein and
the p75^{NTR} receptor.

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Brief Description of Figures

The following standard abbreviations are used throughout the specification to indicate specific nucleotides:

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C=cytosine
A=adenosine
T=thymidine
G=guanosine

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As used herein, amino acid residues are abbreviated as follows:

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A=Alanine
C=Cysteine
D=Aspartic Acid
E=Glutamic Acid
F=Phenylalanine
G=Glycine

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H=Histidine
I=Isoleucine
K=Lysine
L=Leucine
M=Methionine

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N=Asparagine
P=Proline
Q=Glutamine
R=Arginine
S=Serine

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T=Threonine
V=Valine
W=Tryptophan
Y=Tyrosine

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Figure legends

Fig. 1 A-H Amino acid sequence and expression analysis

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of NADE.

Figure 1A

5 Amino acid alignment of mouse and human NADE (HGR74)
(4) proteins. The dotted sequence is asparagine rich
stretch. The asterisks indicate the leucine-rich
nuclear export signal (NES)(5). The closed triangle
indicates cysteine residue essential for dimer
formation. The prenylation sequence in C-termini is
underlined.

Figure 1B

15 Comparison of leucine-rich nuclear export signal (NES)
(5) in various protein. The consensus sequence for
NES are shadowed. Genbank accession numbers are:
cZyxin, X69190; MAPKK, D13700; PKI-a, L02615; TFIIIA,
M85211; RevHIV-1, AF075719; RanBP1, L25255; FMRP,
L29074; Gle1, U68475; Human NADE, submitted; mouse
NADE, submitted.

Figure 1C

20 Consensus sequence of ubiquitination signal.

Figure 1D

25 Northern blot analysis of NADE.

Figure 1E

30 Expression of endogenous NADE protein in SK-N-MC human
neuroblastoma cells. SK-N-MC cell lysate treated with
ALLN is immunoprecipitated by anti-NADE antibody, and
subjected to immunoblotting by same antibody. Human
NADE protein transiently expressed in 293T cells and
untreated gels were used for controls. Heavy chain
bands are resulted from antibodies using
35 immunoprecipitation.

Figure 1F

Mutant analysis of mouse NADE protein A wild type NADE, muNADE(Cys102Ser), and muNADE(Cys121Ser) proteins transiently expressed in 293T cells were detected by immunoblotting with anti-NADE antibody.

- 5 Transfection methods are described in material and methods. The cell lysate extracted from the 293T cells transfected with parental vector was used as a control.

10 **Figure 1G-1 and 1G-2**

Blast Search and comparison of mouse NADE nucleic acid sequence Figure 1G-1 (SEQ ID NO: __) and human protein HGR74 sequence

15 **Figure 1H**

Comparison of mouse NADE, human HGR74 protein and other homologous rat, mouse and human amino acid sequences

- 20 **Fig. 2A-C** NADE binds to p75^{NTR} strongly *in vitro* and *in vivo*.

Figure 2A

- 25 *In vitro* binding assay of NADE and p75^{NTR}. *In vitro*-translated NADE protein was subjected to GST-pull down assay using a GST-p75^{NTR}ICD fusion protein. GST was used as a control.

Figure 2B

- 30 *In vivo* binding assay of NADE and p75^{NTR}. The cell lysates extracted from 293T cells co-transfected with Myc-tagged NADE and p75^{NTR} were co-immunoprecipitated by anti-Myc antibody, and subjected to immunoblotting by anti-p75^{NTR} antibody. The lysates from the cells
35 transfected with each plasmid and a parental vector were used as controls. Transfection methods are described in material and methods.

Figure 2C

Interaction of NADE with p75^{NTR} depending on NGF ligation. 293T cells co-transfected with Myc-tagged NADE and p75^{NTR} were treated with NGF in various concentration as indicated. Upper panel; Immunoprecipitates of anti-Myc antibody (IgG1) from each sample were subjected to immunoblotting analysis by anti p75^{NTR} antibody. Middle and lower panels indicated the expression level of p75^{NTR} and NADE proteins by immunoblotting, respectively. The immunoprecipitate of anti-FLAG antibody (IgG1) was used as a control.

Fig. 3A-E Effect of NADE and p75^{NTR} co-transfection on 293T cells.

Figure 3A

Morphological change caused by co-transfection of NADE and p75^{NTR} in 293T cells transfected by each cDNA were observed 48 hours after transfection. The magnification was 200. Transfection methods are described in material and methods.

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Figure 3B

TUNEL assay. Transfected 293T cells were stained by TUNEL method and analyzed by a flow cytometer. The percentages indicated are positive populations.

Figure 3C

DNA fragmentation analysis. DNAs from transfected 293T cells were checked by 1.5 % agarose gel electrophoresis.

Figure 3D

Inhibition of NF- κ B activity by NADE. NF- κ B activities in transfected cells were measured by E-selectin promoter-luciferase gene reporter assay. Luciferase activities were determined 24 hours after transfection and normalized on the basis of pRL-TK expression levels.

Figure 3E

Activation of Caspase-2 and 3 and degradation of PARP in co-transfected 293T cells. The cell extracts from 293T cells transfected by each cDNA as indicated were analyzed by immunoblotting with anti-Caspase-2, Caspase-3, and PARP antibody. The level of α -tubulin was measured as a control.

Fig. 4A-D A conserved Rev-like NES in the C-terminus mediates nuclear export of NADE protein.

Figure 4A

At residues 88-100, the mouse NADE NES lies within the C-terminus. A mouse NADE is aligned with homologous sequences of NADE family members and the NES sequences of HIV Rev, MAPKK, cZyxin and PKI-a.

Figure 4B

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Subcellular localization of a wild type mNADE-GFP and a control GFP vector was analyzed in transfected 293T cells.

5 **Figure 4C**

Effects of deletion mutants of NES motif on nuclear export of GFP-fused mouse NADE proteins. Both deletion mutants with or without NES indicate deletion-124 and delta 91-124, respectively.

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Figure 4D

Effects of point mutations within the NES motif on nuclear export of GFP-fused mouse NADE proteins. The single or double amino acid substitutions were made at residue 94 and 97 (Leu to Ala). GFP-constructs were transiently transfected into 293T cells. The fixed cells were stained with TO-PRO-3 to visualize the nucleus and images of representative cell fields were captured on a confocal laser microscope. More than 1000 cells were analyzed for each construct.

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Detailed Description of the Invention

The following standard abbreviations are used throughout the specification to indicate specific
5 nucleotides:

C=cytosine
A=adenosine
T=thymidine
10 G=guanosine

As used herein, amino acid residues are abbreviated as follows:

15 A=Alanine
C=Cysteine
D=Aspartic Acid
E=Glutamic Acid
F=Phenylalanine
20 G=Glycine
H=Histidine
I=Isoleucine
K=Lysine
L=Leucine
25 M=Methionine
N=Asparagine
P=Proline
Q=Glutamine
R=Arginine
30 S=Serine
T=Threonine
V=Valine
W=Tryptophan
Y=Tyrosine

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This invention provides an isolated nucleic molecule encoding a polypeptide capable of binding a p75^{NTR}

receptor. In an embodiment of the above described isolated nucleic molecule encoding a polypeptide capable of binding a p75^{NTR} receptor the isolated nucleic acid is a DNA molecule. In another embodiment of the above described isolated nucleic acid molecule encoding a polypeptide capable of binding a p75^{NTR} receptor the isolated nucleic acid is a cDNA molecule. In a further embodiment of the above described isolated DNA molecule encoding a polypeptide capable of binding a p75^{NTR} receptor the isolated nucleic acid is a RNA molecule. In an embodiment of the above described isolated nucleic acid molecule encoding a polypeptide capable of binding a p75^{NTR} receptor, the isolated nucleic acid is operatively linked to a promoter of RNA transcription. In yet another embodiment of the above described nucleic acid molecule, said isolated nucleic acid molecule encodes a neurotrophin associated cell death executor protein. In an embodiment of the above described nucleic acid molecule, said isolated nucleic acid molecule comprises a sequence of AATTG TCTAC GCATC CTTAT GGGGG AGCTG TCTAA C.

As used herein, "polypeptide" includes both peptides and proteins. "Peptide" means a polypeptide of fewer than 10 amino acid residues in length, and "protein" means a polypeptide of 10 or more amino acid residues in length. In this invention, the polypeptides may be naturally occurring or recombinant (i.e. produced via recombinant DNA technology), and may contain mutations (e.g. point, insertion and deletion mutations) as well as other covalent modifications (e.g. glycosylation and labeling [via biotin, streptavidin, fluoracine, and radioisotopes such as ¹³¹I]). Moreover, each instant composition may contain more than a single

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5 The DNA molecules described and claimed herein are
useful for the information which they provide
concerning the amino acid sequence of the polypeptide
capable of binding a p75^{NTR} receptor, and as products
for the large scale synthesis of the polypeptide
capable of binding a p75^{NTR} receptor, or fragments
thereof, by a variety of recombinant techniques. The
DNA molecule is useful for generating new cloning and
10 expression vectors, transformed and transfected
prokaryotic and eukaryotic host cells, and new and
useful methods for cultured growth of such host cells
capable of expression of the polypeptide capable of
binding a p75^{NTR} receptor or portions thereof and
15 related products.

20 This invention provides a vector which comprises the
isolated nucleic acid encoding a polypeptide capable
of binding a p75^{NTR} receptor, operatively linked to a
promoter of RNA transcription. In an embodiment of
the invention, where in the vector which comprises the
isolated nucleic acid encoding a polypeptide capable
of binding a p75^{NTR} receptor, operatively linked to a
promoter of RNA transcription is a plasmid. In
25 another embodiment the above described isolated
nucleic acid molecule which is a cDNA molecule
encoding a polypeptide capable of binding a p75^{NTR}
receptor, encodes a human or mouse protein. In yet
another embodiment the above described isolated
30 nucleic acid molecule is a cDNA molecule wherein the
nucleic acid molecule encodes a polypeptide capable of
binding a p75^{NTR} receptor comprising the amino acid
sequence set forth in Figure 1G-1 (SEQ ID NO: ____). In
a further embodiment the above described isolated
35 nucleic acid molecule is a cDNA molecule wherein the



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optimal synthesis of mRNA. These additional elements may include splice signals, as well as enhancers and termination signals. For example, a bacterial expression vector includes a promoter such as the lac promoter and for transcription initiation the Shine-Dalgarno sequence and the start codon AUG. Similarly, a eukaryotic expression vector includes a heterologous or homologous promoter for RNA polymerase II, a downstream polyadenylation signal, the start codon AUG, and a termination codon for detachment of the ribosome. Such vectors may be obtained commercially or assembled from the sequences described by methods well known in the art, for example the methods described above for constructing vectors in general.

These vectors may be introduced into a suitable host cell to form a host vector system for producing the inventive proteins. Methods of making host vector systems are well known to those skilled in the art.

Methods of introducing nucleic acid molecules into cells are well known to those of skill in the art. Such methods include, for example, the use of viral vectors and calcium phosphate co-precipitation.

This invention provides a host cell comprising the vector comprising the nucleic acid molecule of encoding a polypeptide capable of binding p75^{NTR} receptor. In an embodiment the above described host cell is selected from a group consisting of a bacterial cell, a plant cell, and insect cell, and a mammalian cell.

The "suitable host cell" in which the nucleic acid molecule encoding is a polypeptide capable of binding

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5 molecule encoding a polypeptide capable of binding a
p75^{NTR} receptor. In an embodiment of the above
described isolated nucleic acid molecule of at least
15 contiguous nucleotides capable of specifically
hybridizing with a unique sequence included within the
sequence of the nucleic acid molecule encoding a
polypeptide capable of binding a p75^{NTR} receptor, said
isolated nucleic acid molecule is a DNA molecule. In
another embodiment of the above described isolated
10 nucleic acid molecule of at least 15 contiguous
nucleotides capable of specifically hybridizing with
a unique sequence included within the sequence of the
nucleic acid molecule encoding a polypeptide capable
of binding a p75^{NTR} receptor, said isolated nucleic
15 molecule is a RNA molecule.

20 This invention provides an isolated nucleic acid
molecule capable of specifically hybridizing with a
unique sequence included within the sequence of a
nucleic acid molecule which is complementary to the
nucleic acid molecule encoding a polypeptide capable
of binding a p75^{NTR} receptor. In an embodiment the
above described isolated nucleic acid molecule which
is complementary to the nucleic acid molecule encoding
25 a polypeptide capable of binding a p75^{NTR} receptor is
a DNA molecule. In another embodiment the above
described isolated nucleic acid molecule capable of
specifically hybridizing with a nucleic acid molecule
capable of specifically hybridizing with a unique
30 sequence included within the sequence of a nucleic
acid molecule which is complementary to the nucleic
acid molecule encoding a polypeptide capable of
binding a p75^{NTR} receptor is a RNA molecule.

35 One of ordinary skill in the art will easily obtain

unique sequences from the cDNA cloned in the polypeptide capable of binding a p75^{NTR} receptor plasmid. Such unique sequences may be used as probes to screen various mammalian cDNA libraries and genomic DNAs, e.g. mouse, rat and bovine, to obtain homologous nucleic acid sequences and to screen different cDNA tissue libraries to obtain isoforms of the obtained nucleic acid sequences. Nucleic acid probes from the cDNA cloned in the polypeptide capable of binding a p75^{NTR} receptor plasmid may further be used to screen other human tissue cDNA libraries to obtain isoforms of the nucleic acid sequences encoding polypeptide capable of binding a p75^{NTR} receptor as well as to screen human genomic DNA to obtain the analogous nucleic acid sequences. The homologous nucleic acid sequences and isoforms may be used to produce the proteins encoded thereby.

As used herein, "capable of specifically hybridizing" means capable of binding to an mRNA molecule encoding a polypeptide capable of binding a p75^{NTR} receptor but not capable of binding to a polypeptide capable of binding a p75^{NTR} receptor molecule encoding a polypeptide capable of binding a p75^{NTR} receptor.

This invention provides an antisense oligonucleotide having a nucleic acid sequence capable of specifically hybridizing to an mRNA molecule encoding a polypeptide capable of binding a p75^{NTR} receptor. In an embodiment of the above described antisense oligonucleotide, said antisense oligonucleotide has a nucleic acid sequence capable of specifically hybridizing to the isolated cDNA molecule encoding a polypeptide capable of binding a p75^{NTR} receptor. In another embodiment of the above described antisense oligonucleotide has a

nucleic acid sequence capable of specifically hybridizing to the isolated RNA molecule encoding a polypeptide capable of binding a p75^{NTR} receptor.

5 This invention provides a purified a polypeptide capable of binding a p75^{NTR} receptor. In an embodiment of the above described purified polypeptide capable of binding p75^{NTR} receptor is encoded by the isolated nucleic acid encoding a polypeptide capable of binding
10 a p75^{NTR} receptor. In an embodiment the above described polypeptide capable of binding a p75^{NTR} receptor is a fragment of the purified polypeptide capable of binding a p75^{NTR} receptor. In another embodiment the above described purified polypeptide capable of binding a p75^{NTR} receptor has substantially the same amino acid sequence as set forth in Figure 1G-1 (SEQ ID NO: ____). In a further embodiment the above described purified polypeptide capable of binding a p75^{NTR} receptor having an amino acid sequence
20 as set forth in Figure 1G-1 (SEQ ID NO: ____). In yet another embodiment the above described polypeptide capable of binding a p75^{NTR} receptor has an amino acid sequence as set forth in Figure 1G-1 (SEQ ID NO: ____). In a further embodiment, the above described polypeptide capable of binding a p75^{NTR} receptor is a vertebrate polypeptide capable of binding a p75^{NTR} receptor. In an embodiment of the above described polypeptide capable of binding a p75^{NTR} receptor comprises a neurotrophin associated cell death
25 executor protein. In yet another embodiment of the above described polypeptide capable of binding a p75^{NTR} receptor comprises NCLRILMGELSN.

35 As used herein, purified polypeptides means the polypeptides free of any other polypeptides.

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As used herein, a polypeptide capable of binding a p75^{NTR} receptor having "substantially the same" amino acid sequences as set forth in Figure 1G-1 (SEQ ID NO:) is encoded by a nucleic acid encoding a polypeptide capable of binding a p75^{NTR} receptor, said nucleic acid having 100% identity in the homeodomain regions, that is those regions coding the protein, and said nucleic acid may vary in the nucleotides in the non-coding regions.

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This invention provides a monoclonal antibody directed to an epitope of a polypeptide capable of binding a p75^{NTR} receptor. In an embodiment the above described monoclonal antibody, said monoclonal antibody is directed to a mouse, rat or human polypeptide capable of binding a p75^{NTR} receptor.

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The term "antibody" includes, by way of example, both naturally occurring and non-naturally occurring antibodies. Specifically, the term "antibody" includes polyclonal and monoclonal antibodies, and fragments thereof. Furthermore, the term "antibody" includes chimeric antibodies, wholly synthetic antibodies, and fragments thereof. Optionally, an antibody can be labeled with a detectable marker. Detectable markers include, for example, radioactive or fluorescent markers.

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This invention provides a polyclonal antibody directed to an epitope of the purified protein having the amino sequence as set forth in Figure 1G-1 (SEQ ID NO:). In a further embodiment the above described monoclonal or polyclonal antibodies are directed to the polypeptide capable of binding a p75^{NTR} receptor, having the amino sequence as set forth in Figure 1G-1

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(SEQ ID NO:).

5 Polyclonal antibodies may be produced by injecting a
host animal such as rabbit, rat, goat, mouse or other
animal with the immunogen of this invention, e.g. a
purified mammalian polypeptide capable of binding a
p75^{NTR} receptor or a purified human polypeptide capable
of binding a p75^{NTR} receptor. The sera are extracted
from the host animal and are screened to obtain
10 polyclonal antibodies which are specific to the
immunogen. Methods of screening for polyclonal
antibodies are well known to those of ordinary skill
in the art such as those disclosed in Harlow & Lane,
Antibodies: A Laboratory Manual, (Cold Spring Harbor
15 Laboratories, Cold Spring Harbor, NY: 1988) the
contents of which are hereby incorporated by
reference.

20 The monoclonal antibodies may be produced by
immunizing for example, mice with an immunogen. The
mice are inoculated intra-peritoneally with an
immunogenic amount of the above-described immunogen
and then boosted with similar amounts of the
immunogen. Spleens are collected from the immunized
25 mice a few days after the final boost and a cell
suspension is prepared from the spleens for use in the
fusion.

30 In the practice of the subject invention any of the
above-described antibodies may be labeled with a
detectable marker. In one embodiment, the labeled
antibody is a purified labeled antibody. As used in
the subject invention, the term "antibody" includes,
but is not limited to, both naturally occurring and
35 non-naturally occurring antibodies. Specifically, the

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term "antibody" includes polyclonal and monoclonal antibodies, and binding fragments thereof. Furthermore, the term "antibody" includes chimeric antibodies and wholly synthetic antibodies, and
5 fragments thereof.

Furthermore, the term "antibody" includes chimeric antibodies and wholly synthetic antibodies, and fragments thereof. A "detectable moiety" which
10 functions as detectable labels are well known to those of ordinary skill in the art and include, but are not limited to, a fluorescent label, a radioactive atom, a paramagnetic ion, biotin, a chemiluminescent label or a label which may be detected through a secondary
15 enzymatic or binding step. The secondary enzymatic or binding step may comprise the use of digoxigenin, alkaline phosphatase, horseradish peroxidase, β -galactosidase, fluorescein or streptavidin/biotin. Methods of labeling antibodies are well known in the
20 art.

Determining whether the antibody forms such a complex may be accomplished according to methods well known to those skilled in the art. In the preferred
25 embodiment, the determining is accomplished according to flow cytometry methods.

The antibody may be bound to an insoluble matrix such as that used in affinity chromatography. As used in
30 the subject invention, isolating the cells which form a complex with the immobilized monoclonal antibody may be achieved by standard methods well known to those skilled in the art. For example, isolating may comprise affinity chromatography using immobilized
35 antibody.

Alternatively, the antibody may be a free antibody. In this case, isolating may comprise cell sorting using free, labeled primary or secondary antibodies. Such cell sorting methods are standard and are well known to those skilled in the art.

The labeled antibody may be a polyclonal or monoclonal antibody. In one embodiment, the labeled antibody is a purified labeled antibody. The term "antibody" includes, by way of example, both naturally occurring and non-naturally occurring antibodies. Specifically, the term "antibody" includes polyclonal and monoclonal antibodies, and fragments thereof. Furthermore, the term "antibody" includes chimeric antibodies and wholly synthetic antibodies, and fragments thereof. The detectable marker may be, for example, radioactive or fluorescent. Methods of labeling antibodies are well known in the art.

This invention provides a method of inducing apoptosis in cells which comprises expressing polypeptide capable of binding a p75^{NTR} receptor in the cells.

This invention provides a method of inducing apoptosis in a subject which comprises expressing a polypeptide capable of binding a p75^{NTR} receptor in the subject. In a further embodiment of the method of inducing apoptosis in a subject where the subject is a rat, mouse or human.

As used herein, "subject" means any animal or artificially modified animal. Artificially modified animals include, but are not limited to, SCID mice with human immune systems. In the preferred embodiment, the subject is a human.

This invention provides a transgenic nonhuman mammal which comprises an isolated nucleic acid, encoding a polypeptide capable of binding a p75^{NTR} receptor, which is a DNA molecule. In an embodiment of the above
5 described transgenic nonhuman mammal, the DNA encoding a polypeptide capable of binding a p75^{NTR} receptor is operatively linked to tissue specific regulatory elements.

10 This invention provides a method of determining physiological effects of expressing varying levels of a polypeptide capable of binding a p75^{NTR} receptor in a transgenic nonhuman mammal which comprises producing a panel of transgenic nonhuman mammals, each nonhuman
15 mammal expressing a different amount of a polypeptide capable of binding a p75^{NTR} receptor.

This invention provides a method of producing a polypeptide capable of binding a p75^{NTR} receptor into
20 a suitable vector which comprises: (a) inserting a nucleic acid molecule encoding the polypeptide capable of binding a p75^{NTR} receptor into a suitable vector; (b) introducing the resulting vector into a suitable host cell; (c) selecting the introduced host cell for
25 the expression of the polypeptide capable of binding a p75^{NTR} receptor; (d) culturing the selected cell to produce the polypeptide capable of binding a p75^{NTR} receptor; and (e) recovering the polypeptide capable of binding a p75^{NTR} receptor produced.

30 This invention provides a method of inducing apoptosis of cells in a subject comprising administering to the subject the purified polypeptide capable of binding a p75^{NTR} receptor in an amount effective to induce
35 apoptosis. In an embodiment of the above described

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reduction, remission, or regression of the disease or abnormality. In the practice of this invention the "pharmaceutically acceptable carrier" is any physiological carrier known to those of ordinary skill in the art useful in formulating pharmaceutical compositions.

In one preferred embodiment the pharmaceutical carrier may be a liquid and the pharmaceutical composition would be in the form of a solution. In another equally preferred embodiment, the pharmaceutically acceptable carrier is a solid and the composition is in the form of a powder or tablet. In a further embodiment, the pharmaceutical carrier is a gel and the composition is in the form of a suppository or cream. In a further embodiment the compound may be formulated as a part of a pharmaceutically acceptable transdermal patch.

A solid carrier can include one or more substances which may also act as flavoring agents, lubricants, solubilizers, suspending agents, fillers, glidants, compression aids, binders or tablet-disintegrating agents; it can also be an encapsulating material. In powders, the carrier is a finely divided solid which is in admixture with the finely divided active ingredient. In tablets, the active ingredient is mixed with a carrier having the necessary compression properties in suitable proportions and compacted in the shape and size desired. The powders and tablets preferably contain up to 99% of the active ingredient. Suitable solid carriers include, for example, calcium phosphate, magnesium stearate, talc, sugars, lactose, dextrin, starch, gelatin, cellulose, polyvinylpyrrolidone, low melting waxes and ion

exchange resins.

Liquid carriers are used in preparing solutions, suspensions, emulsions, syrups, elixirs and pressurized compositions. The active ingredient can be dissolved or suspended in a pharmaceutically acceptable liquid carrier such as water, an organic solvent, a mixture of both or pharmaceutically acceptable oils or fats. The liquid carrier can contain other suitable pharmaceutical additives such as solubilizers, emulsifiers, buffers, preservatives, sweeteners, flavoring agents, suspending agents, thickening agents, colors, viscosity regulators, stabilizers or osmo-regulators. Suitable examples of liquid carriers for oral and parenteral administration include water (partially containing additives as above, e.g. cellulose derivatives, preferably sodium carboxymethyl cellulose solution), alcohols (including monohydric alcohols and polyhydric alcohols, e.g. glycols) and their derivatives, and oils (e.g. fractionated coconut oil and arachis oil). For parenteral administration, the carrier can also be an oily ester such as ethyl oleate and isopropyl myristate. Sterile liquid carriers are useful in sterile liquid form compositions for parenteral administration. The liquid carrier for pressurized compositions can be halogenated hydrocarbon or other pharmaceutically acceptable propellant.

Liquid pharmaceutical compositions which are sterile solutions or suspensions can be utilized by for example, intramuscular, intrathecal, epidural, intraperitoneal or subcutaneous injection. Sterile solutions can also be administered intravenously. The compounds may be prepared as a sterile solid

composition which may be dissolved or suspended at the time of administration using sterile water, saline, or other appropriate sterile injectable medium. Carriers are intended to include necessary and inert binders, suspending agents, lubricants, flavorants, sweeteners, preservatives, dyes, and coatings.

The above described pharmaceutical composition comprising a polypeptide capable of binding a p75^{NTR} receptor can be administered orally in the form of a sterile solution or suspension containing other solutes or suspending agents, for example, enough saline or glucose to make the solution isotonic, bile salts, acacia, gelatin, sorbitan monoleate, polysorbate 80 (oleate esters of sorbitol and its anhydrides copolymerized with ethylene oxide) and the like.

The above described pharmaceutical composition comprising a polypeptide capable of binding a p75^{NTR} receptor can also be administered orally either in liquid or solid composition form. Compositions suitable for oral administration include solid forms, such as pills, capsules, granules, tablets, and powders, and liquid forms, such as solutions, syrups, elixirs, and suspensions. Forms useful for parenteral administration include sterile solutions, emulsions, and suspensions.

Optimal dosages to be administered may be determined by those skilled in the art, and will vary with the particular above described pharmaceutical composition comprising a polypeptide capable of binding a p75^{NTR} receptor in use, the strength of the preparation, the mode of administration, and the advancement of the

disease condition or abnormality. Additional factors depending on the particular subject being treated will result in a need to adjust dosages, including subject age, weight, gender, diet, and time of administration.

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As used herein, administering may be effected or performed using any of the various methods known to those skilled in the art. The administration may be intravenous, intraperitoneal, intrathecal, intralymphatical, intramuscular, intralesional, parenteral, epidural, subcutaneous; by infusion, liposome-mediated delivery, aerosol delivery; topical, oral, nasal, anal, ocular or otic delivery.

15 A method of identifying a compound capable of inhibiting binding between $p75^{NTR}$ receptor and a polypeptide capable of binding $p75^{NTR}$ receptor comprising: a) contacting the compound with the polypeptide capable of binding to $p75^{NTR}$ receptor under conditions permitting the binding of the polypeptide capable of binding to $p75^{NTR}$ receptor and $p75^{NTR}$ receptor to form a complex; b) contacting the $p75^{NTR}$ receptor with the mixture from step a); and c) measuring the amount of the formed complexes or the unbound $p75^{NTR}$ receptor or the unbound polypeptide or any combination thereof. In an embodiment of the above described method of identifying a compound capable of inhibiting between $p75^{NTR}$ receptor and a polypeptide capable of binding $p75^{NTR}$ where said polypeptide capable of binding $p75^{NTR}$ is a neurotrophin associated cell death executor. In an embodiment of the above described method of identifying a compound capable of inhibiting between $p75^{NTR}$ receptor and a polypeptide capable of binding $p75^{NTR}$ where said polypeptide capable of binding $p75^{NTR}$ is a human HGR74 protein. In an embodiment of the above described method of

identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a musnade3a sequence as defined on Figure 1H. In
5 an embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a hunade3a1 sequence as defined on Figure 1H. In
10 an embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
a hunade3a2 sequence as defined on Figure 1H. In an
15 embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
a ratnad3a sequence as defined on Figure 1H. In an
20 embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a ratnad3b sequence as defined on Figure 1H. In an
25 embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a musnade3b sequence as defined on Figure 1H. In
30 an embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a humnadel sequence as defined on Figure 1H. In an
35 embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding

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5 p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a ratnadel sequence as defined on Figure 1H. In an
embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a musnadel sequence as defined on Figure 1H. In
an embodiment of the above described method of
identifying a compound capable of inhibiting between
10 p75^{NTR} receptor and a polypeptide capable of binding
p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a humnade2 sequence as defined on Figure 1H.

15 A method of identifying a compound capable of
inhibiting binding between p75^{NTR} receptor and a
polypeptide capable of binding p75^{NTR} receptor, where
said binding forms a complex between p75^{NTR} receptor
and a polypeptide capable of binding p75^{NTR} receptor,
comprising: a) contacting the compound with the p75^{NTR}
20 receptor under conditions permitting the binding of
the polypeptide capable of binding to p75^{NTR} receptor
and p75^{NTR} receptor to form a complex; b) contacting
the p75^{NTR} receptor with the mixture from step a); and
c) measuring the amount of the formed complexes or the
25 unbound p75^{NTR} receptor or the unbound polypeptide or
any combination thereof.

In an embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
30 p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a neurotrophin associated cell death executor
protein. In an embodiment of the above described
method of identifying a compound capable of inhibiting
between p75^{NTR} receptor and a polypeptide capable of
35 binding p75^{NTR} where said polypeptide capable of
binding p75^{NTR} is a human HGR74 protein. In an
embodiment of the above described method of

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identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding p75^{NTR} where said polypeptide capable of binding p75^{NTR} is a musnade3a sequence as defined on Figure 1H. In an embodiment of the above described method of identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding p75^{NTR} where said polypeptide capable of binding p75^{NTR} is a hunade3a1 sequence as defined on Figure 1H. In an embodiment of the above described method of identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding p75^{NTR} where said polypeptide capable of binding p75^{NTR} is a hunade3a2 sequence as defined on Figure 1H. In an embodiment of the above described method of identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding p75^{NTR} where said polypeptide capable of binding p75^{NTR} is a ratnad3a sequence as defined on Figure 1H. In an embodiment of the above described method of identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding p75^{NTR} where said polypeptide capable of binding p75^{NTR} is a ratnad3b sequence as defined on Figure 1H. In an embodiment of the above described method of identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding p75^{NTR} where said polypeptide capable of binding p75^{NTR} is a musnade3b sequence as defined on Figure 1H. In an embodiment of the above described method of identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding p75^{NTR} where said polypeptide capable of binding p75^{NTR} is a humnade1 sequence as defined on Figure 1H. In an embodiment of the above described method of identifying a compound capable of inhibiting between p75^{NTR} receptor and a polypeptide capable of binding

5 p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a ratnad1 sequence as defined on Figure 1H. In an
embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
10 p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a musnad1 sequence as defined on Figure 1H. In
an embodiment of the above described method of
identifying a compound capable of inhibiting between
p75^{NTR} receptor and a polypeptide capable of binding
15 p75^{NTR} where said polypeptide capable of binding p75^{NTR}
is a humnade2 sequence as defined on Figure 1H.

20 This invention provides a method for identifying an
apoptosis inducing compound comprising: (a)
contacting a subject with an appropriate amount of the
compound; and (b) measuring the expression level of
polypeptide capable of binding a p75^{NTR} receptor gene
and p75^{NTR} gene in the subject, an increase of the
expression levels of a polypeptide capable of binding
a p75^{NTR} receptor gene and p75^{NTR} gene indicating that
the compound is an apoptosis inducing compound. In an
embodiment of the above described method for
identifying an apoptosis inducing compound comprising:
25 a) contacting a subject with an appropriate amount of
the compound; and (b) measuring the expression level
of polypeptide capable of binding a p75^{NTR} receptor
gene and p75^{NTR} gene in the subject, an increase of the
expression levels of a polypeptide capable of binding
30 a p75^{NTR} receptor gene and p75^{NTR} gene indicating that
the compound is an apoptosis inducing compound,
wherein the subject is a mammal. In an embodiment of
the above-described method of identifying an apoptosis
inducing compound, wherein the mammal subject is a
35 mouse, rat or human.

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This invention provides a method for identifying an apoptosis inducing compound comprising: (a) contacting a cell with an appropriate amount of the compound; and (b) measuring the expression level of polypeptide capable of binding a p75^{NTR} receptor gene and p75^{NTR} gene in the cell, an increase of the expression levels of polypeptide capable of binding a p75^{NTR} receptor gene and p75^{NTR} gene indicating that the compound is an apoptosis inducing compound.

An apoptosis inducing compound is defined as a compound which may be, but not limited to, antibodies, inorganic compounds, organic compounds, peptides, peptidomimetic compounds, polypeptides or proteins, fragments or derivatives which share some or all properties, e.g. fusion proteins, that induces apoptosis. The compounds may be naturally occurring and obtained by purification, or may be non-naturally occurring and obtained by synthesis.

This invention provides a method for screening cDNA libraries encoding a polypeptide capable of binding a p75^{NTR} receptor sequence using a yeast two-hybrid system and using a p75^{NTR} intracellular domain as a target. In an embodiment of the above described method for screening cDNA libraries for polypeptide capable of binding a p75^{NTR} receptor sequence using a yeast two-hybrid system and using a p75^{NTR} intracellular domain as a target, where the cDNA library is mammalian. In another embodiment of the above described method for screening cDNA libraries for a polypeptide capable of binding a p75^{NTR} receptor using a yeast two-hybrid system and using a p75^{NTR} intracellular domain as a target, where the cDNA library is mammalian and where the mammalian cDNA

library is derived from rat, mouse or human cDNA libraries. In an embodiment of the above described method for screening cDNA libraries for a polypeptide capable of binding a p75^{NTR} receptor, using a yeast two-hybrid system and using a p75^{NTR} intracellular domain as a target, where the p75^{NTR} intracellular domain target is mammalian. In an embodiment of the above described method for screening cDNA libraries for a polypeptide capable of binding a p75^{NTR} receptor using a yeast two-hybrid system and using a p75^{NTR} intracellular domain as a target, where the p75^{NTR} intracellular domain target is a rat, mouse or human p75^{NTR} intracellular domain target.

This invention provides a method to induce caspase-2 and caspase-3 activity to cleave poly (ADP-ribose) polymerase and fragment nuclear DNA in a cell by co-expression of a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR}.

Caspases are members of the protease family, the mammalian homologs of the *Caenorhabditis elegans* death gene ced-3, which are required for mammalian apoptosis. Increased levels of caspase-2 and caspase-3 have been linked to apoptosis. The caspases are cysteine aspartases that cleave their substrates at aspartate residues. To activate caspases, they need to be cleaved at aspartate residues and to form active heterodimers.

This invention provides a method to inhibit NF- κ B activation in a cell with a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR}.

NF- κ B is a primary transcription factor which is

activated by external stimuli, and translocated to the nucleus where it binds to DNA and regulates gene transcription. In rat Schwann cells, the binding of nerve growth factor to p75^{NTR} neurotrophin receptor, induces the activation of NF-κB in the absence of tyrosine kinase receptor A, and led to cell survival. NF-κB regulates the gene expression of various proteins including cell surface molecules and cytokines.

10

This invention provides a method to detect a neurodegenerative disease in a subject by detecting expression levels of a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR}. In an embodiment of the above described method to detect a neurodegenerative disease in a subject by detecting expression levels of a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR}, wherein the subject is a mammal. In another embodiment of the above described method to detect a neurodegenerative disease in a subject by detecting expression levels of a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR} wherein the mammal subject is mouse, rat or human.

25 This invention provides a transgenic nonhuman mammal which comprises an isolated nucleic acid, encoding a human HGR74 protein, which is a DNA molecule. In an embodiment of the above described transgenic nonhuman mammal, the DNA encoding a human HGR74 protein is operatively linked to tissue specific regulatory elements.

This invention provides a method of determining physiological effects of expressing varying levels of a human HGR74 protein in a transgenic nonhuman mammal

which comprises producing a panel of transgenic nonhuman mammal, each nonhuman mammal expressing a different amount of human HGR74 protein.

5 This invention provides a method of producing the isolated human HGR74 protein into a suitable vector which comprises: (a) inserting a nucleic acid molecule encoding a human HGR74 protein into a suitable vector; (b) introducing the resulting vector
10 into a suitable host cell; (c) selecting the introduced host cell for the expression of the human HGR74 protein; (d) culturing the selected cell to produce the human HGR74 protein; and (e) recovering the human HGR74 protein produced.

15 This invention provides a method of inducing apoptosis of cells in a subject comprising administering to the subject the purified human HGR74 protein in an amount effective to induce apoptosis. In an embodiment of
20 the above described method of inducing apoptosis of cells in a subject comprising administering to the subject the purified human HGR74 in an amount effective to induce apoptosis, the subject is a mammal. In another embodiment of the above-described
25 method of inducing apoptosis of cells in a subject, the subject is a mouse, rat or human.

This invention provides a pharmaceutical composition comprising a purified human HGR74 protein and a
30 pharmaceutically acceptable carrier.

This invention provides a method for identifying an apoptosis inducing compound comprising: (a)
35 contacting a subject with an appropriate amount of the compound; and (b) measuring the expression level of

human HGR74 protein gene and p75^{NTR} gene in the subject, an increase of the expression levels of human HGR74 protein gene and p75^{NTR} gene indicating that the compound is an apoptosis inducing compound. In an embodiment of the above described method for identifying an apoptosis inducing compound comprising: a) contacting a subject with an appropriate amount of the compound; and (b) measuring the expression level of human HGR74 protein gene and p75^{NTR} gene in the subject, an increase of the expression levels of human HGR74 protein gene and p75^{NTR} gene indicating that the compound is an apoptosis inducing compound, wherein the subject is a mammal. In an embodiment of the above-described method of identifying an apoptosis inducing compound, wherein the mammal subject is a mouse, rat or human.

This invention provides a method for identifying an apoptosis inducing compound comprising: (a) contacting a cell with an appropriate amount of the compound; and (b) measuring the expression level of human HGR74 gene and p75^{NTR} gene in the cell, an increase of the expression levels of human HGR74 protein gene and p75^{NTR} gene indicating that the compound is an apoptosis inducing compound.

This invention provides a method for screening cDNA libraries human HGR74 sequence using a yeast two-hybrid system using a p75^{NTR} intracellular domain as a target. In an embodiment of the above described method for screening cDNA libraries human HGR74 sequence using a yeast two-hybrid system using a p75^{NTR} intracellular domain as a target, where the cDNA library is mammalian. In an embodiment of the above described method for screening cDNA libraries human

5 HGR74 sequence using a yeast two-hybrid system using
a p75^{NTR} intracellular domain as a target, where the
cDNA library is mammalian and where the mammalian cDNA
library is derived from rat, mouse or human cDNA
libraries. In another embodiment of the above
described method for screening cDNA libraries human
HGR74 sequence using a yeast two-hybrid system using
a p75^{NTR} intracellular domain as a target, where the
p75^{NTR} intracellular domain target is mammalian. In an
10 embodiment of the above described method for screening
cDNA libraries human HGR74 sequence using a yeast two-
hybrid system using a p75^{NTR} intracellular domain as a
target, where the p75^{NTR} intracellular domain target is
a rat, mouse or human p75^{NTR} intracellular domain
15 target.

20 This invention provides a method to induce caspase-2
and caspase-3 activity to cleave poly (ADP-ribose)
polymerase and fragment nuclear DNA in a cell by co-
expression of human HGR74 protein and p75^{NTR}.

25 This invention provides a method to inhibit NF- κ B
activation in a cell with human HGR74 protein and
p75^{NTR}.

30 This invention provides a method to detect a
neurodegenerative disease in a subject by detecting
expression levels of polypeptide capable of binding a
p75^{NTR} receptor and p75^{NTR}. In an embodiment of the
above described method to detect a neurodegenerative
disease in a subject by detecting expression levels of
polypeptide capable of binding a p75^{NTR} receptor and
p75^{NTR}, wherein the subject is a mammal. In another
embodiment of the above described method to detect a
35 neurodegenerative disease in a subject by detecting

expression levels of polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR}, wherein the subject is a mammal wherein the mammal is human.

5 This invention provides a method of identifying a compound, which is an apoptosis inhibitor, said compound is capable of inhibiting specific binding between a polypeptide capable of binding a p75^{NTR} receptor and p75^{NTR} receptor, so as to prevent
10 apoptosis which comprises: (a) contacting the polypeptide capable of binding a p75^{NTR} receptor with a plurality of compounds under conditions permitting binding between a known compound previously shown to be able to displace the polypeptide capable of binding
15 a p75^{NTR} receptor and the p75^{NTR} receptor and the bound p75^{NTR} receptor to form a complex; and (b) detecting the displaced polypeptide capable of binding a p75^{NTR} receptor or the complex formed in step (a), wherein the displacement indicates that the compound is
20 capable of inhibiting specific binding between the polypeptide capable of binding a p75^{NTR} receptor and the p75^{NTR} receptor. In another embodiment of the above described method, wherein the inhibition of specific binding between the polypeptide capable of binding a
25 p75^{NTR} receptor and the p75^{NTR} receptor affects the transcription activity of a reporter gene. In a further embodiment of the above described method, wherein step (b) the displaced polypeptide capable of binding a p75^{NTR} receptor or the complex is detected by
30 comparing the transcription activity of a reporter gene before and after the contacting with the compound in step (a), where a change of the activity indicates that the specific binding between the polypeptide capable of binding a p75^{NTR} receptor and the p75^{NTR}
35 receptor is inhibited and the polypeptide capable of

binding a p75^{NTR} receptor is displaced. In an
embodiment of the above described method, wherein the
p75^{NTR} receptor is bound to a solid support. In a
further embodiment of the above described method,
5 wherein the compound is bound to a solid support. In
an embodiment of the above described method, wherein
the compound comprises an antibody, an inorganic
compound, an organic compound, a peptide, a
peptidomimetic compound, a polypeptide or a protein.
10 In an embodiment of the above described method,
wherein the contacting of step (a) is in vitro. In
a further embodiment of the above method, wherein the
contacting of step (a) is in vivo. In an embodiment
of the above method, wherein the contacting of step
15 (a) is in a yeast cell. In an embodiment of the above
method, wherein the contacting or step (a) is in a
mammalian cell. In an embodiment of the above method,
wherein the polypeptide capable of binding a p75^{NTR}
receptor is a cell surface receptor. In an embodiment
20 of the above method, wherein the cell-surface receptor
is the p75 receptor.

As used herein, the "transcription activity of a
reporter gene" means that the expression level of the
25 reporter gene will be altered from the level observed
when the signal-transducing protein and the
cytoplasmic protein are bound. One can also identify
the compound by detecting other biological functions
dependent on the binding between the signal-
30 transducing protein and the cytoplasmic protein.
Examples of reporter genes are numerous and well-known
in the art, including, but not limited to, histidine
resistant genes, ampicillin resistant genes, β -
galactosidase gene.

Further the cytoplasmic protein may be bound to a solid support. Also the compound may be bound to a solid support and comprises an antibody, an inorganic compound, an organic compound, a peptide, a peptidomimetic compound, a polypeptide or a protein.

An example of the method is provided infra. One can identify a compound capable of inhibiting specific binding between the signal-transducing protein and the cytoplasmic protein using direct methods of detection such as immuno-precipitation of the cytoplasmic protein and the compound bound to a detectable marker. Further, one could use indirect methods of detection that would detect the increase or decrease in levels of gene expression. As discussed infra, one could construct synthetic peptides fused to a LexA DNA binding domain. These constructs would be transformed into the L40-strain with an appropriate cell line having an appropriate reporter gene. One could then detect whether inhibition had occurred by detecting the levels of expression of the reporter gene. In order to detect the expression levels of the reporter gene, one skilled in the art could employ a variety of well-known methods, e.g. two-hybrid systems in yeast, mammals or other cells.

Further, the contacting of step (a) may be in vitro, in vivo, and specifically in an appropriate cell, e.g. yeast cell or mammalian cell. Examples of mammalian cells include, but not limited to, the mouse fibroblast cell NIH 3T3, CHO cells, HeLa cells, Ltk⁻ cells, Cos cells, etc.

Other suitable cells include, but are not limited to, prokaryotic or eukaryotic cells, e.g. bacterial cells

This invention provides a method of identifying a compound, which is an apoptosis inhibitor, said compound is capable of inhibiting specific binding between human HGR74 protein and p75^{NTR} receptor, so as to prevent apoptosis which comprises: (a) contacting the human HGR74 protein with a plurality of compounds under conditions permitting binding between a known compound previously shown to be able to displace the human HGR74 protein and the p75^{NTR} receptor and the bound p75^{NTR} receptor to form a complex; and (b) detecting the displaced human HGR74 protein or the complex formed in step (a), wherein the displacement indicates that the compound is capable of inhibiting specific binding between the human HGR74 protein and the p75^{NTR} receptor. In an embodiment of the above described method, wherein the inhibition of specific binding between the human HGR74 protein and the p75^{NTR} receptor affects the transcription activity of a reporter gene. In a further embodiment of the above described method, wherein step (b) the displaced human HGR74 protein or the complex is detected by comparing the transcription activity of a reporter gene before and after the contacting with the compound in step (a), where a change of the activity indicates that the specific binding between the human HGR74 protein and the p75^{NTR} receptor is inhibited and the human HGR74 protein is displaced. In an embodiment of the above described method, wherein the p75^{NTR} receptor is bound to a solid support. In a further embodiment of the above described method, wherein the compound is bound to a solid support. In an embodiment of the above described method, wherein the compound comprises an

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identify a compound capable of inhibiting specific binding between the signal-transducing protein and the cytoplasmic protein using direct methods of detection such as immuno-precipitation of the cytoplasmic protein and the compound bound to a detectable marker. Further, one could use indirect methods of detection that would detect the increase or decrease in levels of gene expression. As discussed infra, one could construct synthetic peptides fused to a LexA DNA binding domain. These constructs would be transformed into the L40-strain with an appropriate cell line having an appropriate reporter gene. One could then detect whether inhibition had occurred by detecting the levels of expression of the reporter gene. In order to detect the expression levels of the reporter gene, one skilled in the art could employ a variety of well-known methods, e.g. two-hybrid systems in yeast, mammals or other cells.

Further, the contacting of step (a) may be in vitro, in vivo, and specifically in an appropriate cell, e.g. yeast cell or mammalian cell. Examples of mammalian cells include, but not limited to, the mouse fibroblast cell NIH 3T3, CHO cells, HeLa cells, Ltk⁻ cells, Cos cells, etc.

Other suitable cells include, but are not limited to, prokaryotic or eukaryotic cells, e.g. bacterial cells (including gram positive cells), fungal cells, insect cells, and other animals cells.

In order to facilitate an understanding of the material which follows, certain frequently occurring methods and/or terms are best described in Sambrook, et al., 1989.

5

Experimental Details

Results and Discussions

5 The p75^{NTR} is the first-isolated neurotrophin receptor
and the member of TNFR (tumor necrosis factor
receptor) family (7, 8). However, its functional role
and signaling pathway has remained largely unclear
(9). The existence of p75^{NTR}ICD binding proteins have
10 been implicated since p75^{NTR}ICD does not have a typical
biochemical motif except a C-terminal region well
conserved to a type 2 death domain (10). Recently, it
has been reported that TRAF6 is involved in p75^{NTR}-
mediated signal transduction(11). To further identify
the p75^{NTR}ICD binding proteins, we screened the mouse
15 cDNA libraries by yeast two-hybrid system using a rat
p75^{NTR}ICD as a target and one of positive clones was
identified as a p75^{NTR}-associated cell death executor,
NADE.

20 NADE consists of 124 amino acids and its molecular
weight is calculated to 14,532 dalton. NADE is a
hydrophilic and acidic protein, and the estimated pI
value is 5.97. A BLAST search revealed that NADE has
significant homology to a known human protein HGR74(4)
25 (Fig. 1a), and does not have a significant motif
except the leucine rich nuclear export signal (NES)
(5) (Fig. 1b) and ubiquitination sequences (6) (Fig.
1c) HGR74 was previously reported as an abundant mRNA
expressed in human ovarian granulosa cells, however,
30 its functional role is still unknown. The homology of
these two proteins except the asparagine rich stretch
(a. a. 36-48) of NADE is 92.8%, therefore we conclude
that HGR74 is a human homolog of mouse NADE.

35 Northern blot analysis is revealed that NADE mRNA (1.3
kbp) is found highest in several tissues including
brain, heart, and lung (Fig. 1d). We could also

detect a low level of mRNA expression in stomach, small intestine, and muscle by a long exposure (data not shown). But there was no expression in liver. The additional large band (3.0 kbp) was also observed

5 in testis, suggesting the existence of the alternative splicing form. The endogenous NADE protein was also confirmed in human neuroblastoma cell line, SK-N-MC by immunoprecipitation using the anti-NADE antibody (Fig. 1e). Interestingly, in SK-N-MC, PC12 and PCNA cells,

10 NADE protein can be detected only in the presence of the ubiquitin inhibitor such as ALLN, suggesting that NADE is modified by ubiquitin conjugating system leading to subsequent degradation by the proteasome. The molecular size of NADE is estimated to 22 kDa by

15 the SDS-PAGE, and this size seems to be slightly larger than the molecular weight predicted from nucleotide sequence. But the gap of molecular size might be caused by its low pI value or post-translational modification in a potential prenylation

20 site (Fig. 1a). The overexpressed NADE protein in 293T cells showed the two bands, 22 kDa and 44 kDa in SDS-PAGE under the reduced condition at 100 mM dithiothreitol (Fig. 1f). To clarify this question, two NADE mutants were constructed and expressed in

25 293T cells. Since NADE has two cysteine residues at sequence positions 102 and 121, we replaced the each cysteine with the serine residue. Western blot analysis revealed that the molecular weight of muNADE (Cys121Ser) is identical to a wild type, on the other

30 hand, muNADE (Cys102Ser) showed the only smaller band of 22 kDa (Fig. 1g). These results strongly suggested that NADE can heterodimerize by the disulfide bond at the Cys102, and resulted in the 44 kDa band.

35 *In vitro*-translated mouse NADE protein and *E. coli*-expressed GST-p75^{NTR}ICD fusion protein were used for *in vitro* GST pull down assay. In this assay, the NADE

protein showed the strong binding activity to GST-P
p75^{NTR}ICD (Fig. 2a). To investigate the *in vivo*
binding activity, the Myc-tagged NADE and p75^{NTR} were
co-expressed in 293T cells and subjected to the co-
immunoprecipitation experiment. The results clearly
showed that NADE could bind to a full length of p75^{NTR}
in vivo very strongly (Fig. 2b) and the recruitment of
NADE protein to p75^{NTR}ICD was detected in a dose
dependent of NGF (Fig. 2c), suggesting that NADE
protein is a putative signal transducing protein
interacting with p75^{NTR}ICD. Furthermore, our mapping
studies revealed that NADE protein interacts with the
cell death domain (amino acid residues 338-393) which
is identical among mouse, rat and human (data not
shown). Since TRAF6 binds a conserved juxtamembrane
region (11), it is unlikely that NADE protein inhibits
TRAF6 binding to p75^{NTR}. It has been speculated that
the polymerization of p75^{NTR} is important for its
signal transduction similar to the another members of
TNFR family. For example, TNFRI (12), CD40 (13), and
Fas (14) are formed the trimer through the binding of
each trimer ligands to extracellular domain. However,
there was no previous report for p75^{NTR} in same manner
(15). It may be possible that the dimer formation of
p75^{NTR} occurs through the binding of NADE dimer to its
intracellular domain.

To investigate the functional role of NADE protein,
NADE and p75^{NTR} were co-transfected in 293T cells. The
results showed that the co-transfected 293T cells were
detached from the dish and aggregated 48 hours later
(Fig. 3a). However, 293T cells transfected with the
control plasmid DNAs showed no significant differences
(Fig. 3a), implicating that this morphological change
is caused by apoptosis. We further examined the TUNEL
assay (TdT-mediated dUTP-biotin nick end labeling
assay) (16) as well as the DNA fragmentation test on

these cells. On the TUNEL assay, the significant increase of dying cell was detected only in co-transfected cells (Fig. 3b) and the value of the positive cell percentage (38%) was consistent with the transfection efficiency by the calcium-phosphate method. Furthermore, the DNA fragmentation was detected in only the co-transfected 293T cells (Fig. 3c). From these results, we conclude that the co-expression of NADE and p75^{NTR} induced apoptosis in 293T cells.

Although NADE protein is recruited to the cytoplasmic region of p75^{NTR} in a ligand-dependent manner, NGF-dependent cell death was not clearly detected in the co-transfected 293T cells in the presence of NGF (100 ng/ml) (data not shown), suggesting that NADE protein may function in the p75^{NTR}-mediated cell death machinery to transduce the downstream signal to apoptosis independent on NGF.

To further investigate the physiological function of NADE protein, we checked the transcription factor kappa B (NF-kB), Caspase-2, and Caspase-3 activities in 293T cells co-transfected with NADE and p75^{NTR}. NF-kB is activated by external stimuli, and translocated to the nucleus where it binds to DNA and regulates gene transcription (17). In rat Schwann cells, the binding of NGF to p75^{NTR} induces the activation of NF-kB with independent manner of TrkA (18) leading to the cell survival and TRAF6 may be a component of NGF-mediated NF-kB activation (11). In contrast, expression of NADE protein significantly suppressed the NF-kB activity in a dose dependent manner, but this effect was not markedly co-operative with p75^{NTR} expression (Fig. 3d) as well as NGF-dependent manner (data not shown), implicating that p75^{NTR}/NADE-induced apoptosis may not be due to only the suppression of

NF-kB activity but also the regulation of unknown signal molecules since NF-kB suppression by NADE protein alone could not induce apoptosis. It has been reported that suppression of NF-kB activity increases cell death in PC12 cells expressing p75^{NTR} (19, 20). NADE protein may play a key role in the downregulation of NF-kB activity and ultimately lead to apoptosis in neuronal cells expressing p75^{NTR}.

10 In many cases of apoptosis, the elevation of Caspase-3 activity was observed (21, 22, 23, 24). This protease normally exists in cytosol of cells as 32 kDa precursor that is proteolytically activated into a 20 kDa and a 10 kDa heterodimer when cells are signaled to undergo apoptosis in response to serum withdrawal, activation of Fas, treatment with ionization, and a variety of pharmacological agents (25). Western blot analysis revealed that Caspase-2 and Caspase-3 were significantly processed only in 293T cells co-transfected with NADE and p75^{NTR} (Fig. 3e). Moreover, PARP (poly (ADP-ribose) polymerase) which is a substrate for both Caspase-2 and Caspase-3 were partially cleaved, indicating that these Caspases are involved in apoptosis mediated by p75^{NTR}/NADE signal transduction

To investigate whether NES sequences (5) contained in NADE (Fig. 4a) have the capability to export a protein from the nucleus to the cytosol, we performed the transient expression in 293T cells using a series of NADE mutants. The results indicated that NADE proteins with NES sequences localize in the cytoplasmic region (Fig. 4, lower panels of b, upper panels of c and d), but NADE proteins with NES mutations express in the nucleus (Fig. 4, lower panel of c and d). These data support the hypothesis that NADE protein can be exported from the nucleus to the

cytosol and may be post-translationally modified as a prenylated protein to promote and regulate p75^{NTR}/NADE physiological interaction.

5 The signal cascade mediated by p75^{NTR} has been enigmatic for a long time. But the recent growing evidences indicate that, not like other members of TNFR family, p75^{NTR} can bifunctionally mediate signals to induce and inhibit apoptosis (26, 27). Our results
10 strongly supported that NADE is a putative signal transducer for p75^{NTR}-mediated apoptosis. Although NADE can mediate apoptosis cooperative with p75^{NTR}, it is possible that NADE may be a signal adaptor molecule to interact with another effector molecules in p75^{NTR}-
15 mediated signal transduction. More importantly, since NADE has nuclear export signal (NES) as well as ubiquitination sequence, NADE may be tightly controlled by the ubiquitin/proteasome to shuttle another molecule from the nucleus to the cytoplasm, implicating that NADE is a very important protein for
20 turnover of regulator gene such as the cell cycle-related proteins. Further investigation under physiological condition will give us more insight to better understand the mechanisms by which NADE can induce apoptosis together with p75^{NTR} expression.
25

Methods

Isolation of p75^{NTR}-associated cell death executor (NADE) by yeast two-hybrid system.

30 In order to isolate cDNA encoding p75^{NTR}-associated proteins, we used yeast two-hybrid system, originally developed by Fields and Song (28). We used the cytosolic domain of rat p75^{NTR} cDNA corresponding to
35 amino acids 338-396 (representing the cytosolic domain of the protein from the transmembrane domain to the C-terminus of the protein) as a target. This portion of

p75^{NTR} cDNA was PCR-engineered into the yeast expression plasmid pBTM116 in-frame with sequences encoding the LexA DNA-binding domain (29). This plasmid was then introduced into L40 cells [a, his3, trp1, leu2, ade2, lys2: (lexAop)⁴-HIS3, URA3: (lexAop)⁸-lacZ] which contain histidine synthetase (HIS3) and b-galactosidase (lacZ) reporter genes under the control of lexA operators (29). After confirming the expression of LexA-p75^{NTR} (338-396) protein by immunoblotting using an antiserum specific for LexA, a mouse embryo pVP16 cDNA libraries were then introduced into these LexA/p75^{NTR}-expressing cells by a high efficiency LiOAc transformation method (30, 31, 32). From a screen of 5 x 10⁷ transformants, an initial set of 672 His⁺ colonies were identified. These 672 clones were then tested by a β -galactosidase colorimetric assay (33), utilizing the lacZ reporter gene under the control of 8 lexA operators, thus narrowing down the pool of candidate clones to 181. These 181 candidates were then "cured" of their LexA/p75^{NTR}-encoding plasmids by growth in tryptophan containing media, and mated with a panel of Mata-type yeast strain NA87-11A [a, leu2, his3, trp1, pho3, pho5] into which we had introduced various control plasmids that produce LexA fusion proteins, including LexA/p75^{NTR}, LexA/Ras, Lex/CD40, LexA/Fas, and LexA/lamin. Among the 181 candidate clones, 1 clone specifically reacted with the LexA/p75^{NTR} protein was chosen for further analysis. This mouse cDNA clone No. 59 has insert sizes of 450 bp. Because of its ability to induce cell death with expression of p75^{NTR}, we have named this protein, NADE (p75^{NTR}-associated cell death executor).

35 **DNA construction.**

A full length mouse NADE cDNA was constructed on pBluescript II vector by the ligation of the partial

Sw
LH
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NADE cDNA (7-524) and 5'-RACE product. PCR cloning techniques were used to replace the stop codon and add the 5' *XhoI* site and 3' *BamHI* site of a full length NADE cDNA. pcDNA3.1(-)Myc-HisA/NADE was constructed by
5 insertion of a full length NADE cDNA to *XhoI*-*BamHI* site of pcDNA3.1(-)Myc-HisA (Invitrogen). Human NADE cDNA was amplified using a Jurkat T cell cDNA library and cloned to pcDNA3.1(-)Myc-HisA pcDNA3/rat p75^{NTR} was constructed by insertion of a full length rat p75^{NTR} cDNA to *EcoRI* site of pcDNA3 (Invitrogen). pGEX4T-
10 1/rat p75^{NTR}ICD was constructed by insertion of amplified rat p75^{NTR}ICD (a. a. 338-396) to pGEX4T-1 (Pharmacia). Mutant NADE expression plasmids, pcDNA3.1(-)Myc-HisA/muNADE (Cys102Ser) and pcDNA3.1(-)
15 1/rat p75^{NTR}ICD (Cys121Ser), were constructed by PCR-based site-direct mutagenesis methods (29). pELAM-Lu for luciferase reporter assay was constructed by insertion of NF- κ B binding site of E-selectin promoter region (-730 - 52) to pGL3-Basic *SacI*-*BglIII* site.
20 Expression plasmids of GFP-fused NADE proteins were made following: The cDNA of GFP was cloned into *NheI*-*XhoI*-cut pcDNA3.1-mouse NADE as a PCR product amplified with the primers 5"-CTAGCTAGCATCATGGTGAGCAAGGGCGAG-3" and 5"-CCGCTCGAGTCTTGTACAGCTCGTCCAT-3" using pEGFP-N2
25 (Clontech) as a template. The deletion mutants delta 101-124-GFP and delta 91-124-GFP were constructed by inserting an *XhoI*-*BamHI*-cut PCR fragment generated with Expand high fidelity Taq polymerase (Boehringer Mannheim) into *XhoI*-*BamHI*-cut pcDNA3.1-GFP using the
30 primers
5"-ATCCTCGAGCGATCATGGCCAATGTCCAC-3" (sense),
5"-ATCGGATCCTCTCAGCTGTAGCTCCCT-3" (antisense) and
5"-ATCGGATCCGATCTCTCTCATCTCCTC-3" (antisense).

35

The mutagenic primers

(5'-AAAGCTTAGGGAGGCACAGCTGAGAAA-3",

5"-TTTCTCAGCTGTGCCTCCCTAAGCTTT-3",
5"-ATCCGGAGAAAGGCTAGGGAGGCACA-3",
and 5"-TGTGCCTCCCTAGCCTTTCTCCGGAT-3")

were used to obtain L97A-GFP and L94, 97A-GFP in which
Leu94 and Leu97 are replaced with Ala. In all
constructs, mutations were verified by sequencing.

Northern blot analysis. 400 ng of NADE cDNA fragments
(nt. 5-510) were labeled by 50 μ Ci of [α - 32 P]dCTP and
used as a probe. Each 10 μ g of total mRNA extracted
from mouse various tissues were transferred on
membranes and they were hybridized with a NADE probe
for 2 hours at 68 °C using a express hybrid buffer
(Clontech) and washed with 2 x SSC, 0.05 % SDS for 5
times, and 0.1 x SSC, 0.1 % SDS for 1 time.

Antibodies. The polyclonal anti-NADE antibody was
prepared by immunization of GST-mouse NADE fusion
protein into the rabbit. The NADE specific antibody
was affinity purified by antigen coupled Sepharose 4B.
The polyclonal anti-rat p75^{NTR} was kindly gifted from
Dr. M. V. Chao. The monoclonal anti-Myc antibody
(9E10) was purchased from BIOMOL. The polyclonal
anti-Caspase-3 antibody (H-277) was purchased from
Santa Cruz Biotechnology. The polyclonal Caspase-2
antibody was kindly gifted from Dr. Lloyd A. Greene.
HRP conjugated anti-rabbit IgG was purchased from Bio-
Rad.

Immunoprecipitation and immunoblotting. In Fig. 1e,
150 μ g/ml of ALLN (N-Acetyl-Leu-Leu-Norleucinal)
treated SK-N-MC cells (1×10^7) were lysed in 0.5 ml of
RIPA buffer. The supernatant of centrifuge (100,000
x g) was mixed with 1 μ g of polyclonal anti-NADE
antibody coupled Sepharose 4B, and incubated for 4
hours at 4 °C. After washing, the gels were boiled by
30 μ l of SDS-PAGE sampling buffer and subjected to

12.5 % of SDS-PAGE. Immunoblotting was performed by polyclonal anti-NADE antibody (2 µg/ml). In Fig. 1f, 10 µg of cell lysate extracted from each transfected 293T cells were used for the detection of NADE by immunoblotting.

Transfection and protein expression in 293T cell. In Fig. 1f, 293T cells (2×10^6) were transfected by 10 µg of pcDNA3.1(-)Myc-HisA/NADE, pcDNA3.1(-)Myc-HisA/muNADE (Cys102Ser), or pcDNA3.1(-)Myc-HisA/muNADE(Cys121Ser) by calcium-phosphate method. In Fig. 2 b, 3 a, b, c, e, 293T cells (2×10^6) were transfected by 20 µg of pcDNA3.1(-) Myc-HisA, 10 µg of pcDNA3/rat p75^{NTR} and 10 µg of pcDNA3.1(-) Myc-HisA, 10 µg of pcDNA3.1(-)Myc-HisA NADE and 10 µg of pcDNA3.1(-) Myc-HisA, or 10 µg of pcDNA3.1(-)Myc-HisA/NADE and 10 µg of pcDNA3 / rat p75^{NTR}. In Fig. 2 c, 293T cells (2×10^6) were transfected by 10 µg of pcDNA3.1(-)Myc-HisA/NADE and 10 µg of pcDNA3/rat p75^{NTR} in serum minus DMEM medium.

In vitro binding assay. 5 µl of L-[³⁵S] methionine labeled, and in vitro- translated NADE protein was mixed with 5 µl of GST-rat p75^{NTR}ICD fusion protein or GST-coupled GSH-Sepharose 4B (Pharmacia) in 100 µl of NETN buffer (20 mM Tris-HCl pH 8.0, 100 mM NaCl, 1 mM EDTA, 0.2 % NP-40) for 18 hours at 4 °C. After washing, gels were boiled by 30 µl of SDS-PAGE sampling buffer and subjected to 13.5 % SDS-PAGE. The fluolography was performed for 16 hours at -70 °C.

In vivo binding assay. In Fig. 2b, transfected 293T cells by were lysed in 1 ml of NETN buffer and centrifuged (100,000 µg). The supernatants were immunoprecipitated by 2 µg of anti-Myc antibody coupled Protein G Sepharose 4B (Pharmacia) for 2 hours at 4 °C. Following the 5 times washing, gels were

Interaction of NADE with p75^{NTR} dependent on NGF ligation. After co-transfection, cells were incubated in DMEM medium containing various NGF. After 12 hours later, the interaction activity between NADE and p75^{NTR} were checked by *in vivo* binding assay.

15 **DNA fragmentation assay.** Transfected 293T cells were
lysed in 350 μ l of 10 mM EDTA and 0.5 % SDS for 10
minutes at room temperature. After adding 100 μ l of
5 M NaCl, the aliquot was incubated for 18 hours at 4
20 $^{\circ}$ C and centrifuged (12,000 x g). The supernatants
were treated by 1 mg/ml of RNase A and 50 ng/ml of
Proteinase K for 2 hours at 42 $^{\circ}$ C. After the phenol-
chloroform extraction, the DNAs were precipitated by
70 % ethanol, and dissolved in 30 μ l of H₂O. 5 μ l of
25 samples were subjected to the 1.5 % agarose gel
electrophoresis.

Measurement of NF- κ B activity. Dual-Luciferase Reporter Assay System (Promega) was used for measurement of NF- κ B activity. 293T cells (4×10^5) were transfected with 1.5 μ g of pELAM-luc reporter plasmid, 0.1 μ g of pRL-TK, 0.7 μ g of pcDNA3 rat p75^{NTR}, 0.3 μ g or 2.8 μ g of pcDNA3.1(-) Myc-HisA/NADE and enough pcDNA3.1(-) Myc-His a control plasmid to give 5.1 μ g of total DNA. Luciferase activities were determined 24 hours after transfection and normalized on the basis of pRL-TK expression levels. The

Confocal laser microscopy

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